SYNOPSIS
A STUDY OF DIELECTRIC AND ACOUSTIC BEHAVIOR OF POLAR LIQUIDS

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1) ***INTRODUCTION***

Dielectric Study of Polar Liquids is proved as a reliable source in studying this structure and interactions of molecules. We can explain the nature of complex formation between molecules, which is useful to study and their use is in different fields.

Chemical industries and pharma sectors are especially interested in the dielectric and acoustic data of particular compounds for further use.

Ultrasonic is the science of acoustic and technology of sound the study of acoustic had its beginning with the Greek philosophers in 600 BC, Galileo in 1638 showed that the pitch is associated with vibration, ultrasonic technique plays vital role in understanding molecular interactions in pure and binary liquid mixtures for possible applications in biomedical industries and technology. Ultrasonic study is one which is more reliable and commonly used in the study of molecular properties.

2) ***REVIEW OF LITERATURE AND DEVELOPMENT IN THE SUBJECT***

Dielectric Study of materials was first introduced by Professor Debye. Applications of Microwaves in the study of dielectric behavior of binary, tertiary systems increasingly seeking attention by scientific journals and publications.

Ultrasonic branch is widely developed and having various applications in the fields. They can be used to detect solid obstacles, present of liquid or gasses. By appropriate devices such beams can be focused in small regions and produce considerable local heating as well as very large and rapid changes in density. The standard ultrasonic sources are piezoelectric and magnetostriction oscillator, both are electroacoustic devices whose flexibility depends on possibility of designing oscillation electrical circuits to almost any frequency and power specification. Quartz and Rochelle salt are satisfactory and widely used as piezoelectric crystals for ultrasonic transducers.

3) ***OBJECTIVES OF RESEARCH / PROPOSED HYPOTHESIS***

We proposed to study the dielectric and acoustic behavior of polar liquids. We will calculate the dielectric constant, dielectric loss tangent, dipole moment, polarizability, adiabatic compressibility, acoustic impedance, relative association and intermolecular free length etc. Study of dielectric and ultrasonic parameters help in constructing Transformers and capacitors etc. Dielectric permittivity and its strength mostly applicable in making liquid capacitors, random access memories etc.

4) ***METHODOLOGY TO BE ADOPTED***

a) ***DIELECTRIC PARAMETERS.***

The Reflectometric technique is used for measuring reflection coefficient from the dielectric boundary of the sample at microwave frequency. The J/X microwave bench is to be used. The sample is introduced in the sample holding dielectric cell and plunger is moved slowly to change the liquid column in the dielectric cell the maxima and minima are to be noted from standing wave pattern. From this dielectric wavelength (λ_d) has to be calculated. From λ_d measurement the various dielectric parameters are to be calculated by using following equations given in the literature.

$$\varepsilon' = \left(\frac{\lambda_0}{\lambda_c}\right)^2 + \left(\frac{\lambda_0}{\lambda_d}\right)^2 \qquad \text{------(1)}$$

$$\varepsilon'' = \frac{2}{\Pi}\left(\frac{\lambda_0}{\lambda_c}\right)^2 \frac{\lambda_g}{\lambda_d}\left(\frac{d\rho}{dn}\right) \qquad \text{------(2)}$$

$$\tau = \frac{\lambda_0}{2\Pi C}\left(\frac{dy}{dx}\right) \qquad \text{------(3)}$$

$$\mu^2 = \frac{9KTM}{4\Pi Nd}\left[1 + \left(\frac{dy}{dx}\right)^2\right]\frac{dX}{dW} \qquad \text{------(4)}$$

Where, ε' is dielectric constant, ε'' is the dielectric loss, τ is relaxation time and μ is the dipole moment.

b) ***ACOUSTIC PARAMETER***

Using basic physical properties of liquid like ultrasonic velocity, density, viscosity and surface tension many other physical parameters can be obtained such as Adiabatic Compressibility (B), Intermolecular Free Length (L_f), Acoustic Impedance (Z), Relative Association (R_A)

$$\beta = -\frac{1}{v}\frac{dv}{dp} \qquad \text{------(5)}$$

$$L_f = K(\beta_{ad})^{1/2} \qquad \text{------(6)}$$

$$R_A = \frac{\delta_s}{\delta_0}\left(\frac{U_0}{U_s}\right)^{1/3} \qquad \text{------(7)}$$

$$Ultrasonic\ velocity\ (U) = Frequency(f) \times wavelength(\lambda) \qquad \text{------(8)}$$

5) ***IMPORTANCE OF STUDY / SOCIETY APPLICATION***

i) INTERNATIONAL STATUS:

In the present scenario many insecticides and pesticides are proving useless to kill harmful pests on the crops. Worldwide research has taken to produce or research an effective insecticides and pesticides.

As increasingly numbers of packaged food industries worldwide are in search of good flavoring agents which are safe for health. Therefore, the study will be helpful to the industry as useful information/ literature.

The synthesis of many drugs is carried out by pharmaceutical companies worldwide so during the synthesis the compounds containing polar liquids play an important role. Hence the present study can help to the Pharma sector also.

ii) NATIONAL STATUS:

The study of complex permittivity, relaxation of binary mixtures of polar liquids with non-polar liquids has been carried out in almost all Universities. The research work has carried out by using the instruments like TDR, FDR and impedance analyzer (four probe).

Many research paper has been published as directed in molecule interaction study.

6) ***SIGNIFICANCE OF STUDY***

Intermolecular interaction plays a vital role to understand the molecular behavior which helps for developing the drugs, molecule for pesticides and insecticides, food storage capacity, flavoring agent, etc. The dielectric study of polar liquids is important for understanding hydrogen bonding and intermolecular interactions in the mixture. Hence to exploit the benefit of such polar liquids the present work is undertaken.

After investigation of dielectric parameters, we can verify the purity and validity of polar liquids for insecticide, pesticides and geometry of molecules.

The study will use be useful to provide the literature to the pharma field for new synthesis the molecule.

7) ***PROPOSED WORKPLAN / FORMULATION AND STRUCTURE OF STUDY***

Year wise plan of work and target to be achieved.

First year

1. Collection of literature/ research paper.
2. Study of basic theory of dielectric and acoustic behavior of polar liquids.

Second year

1. Selection of properties of polar liquids purchasing chemicals of high grade.
2. Experimental training of J / X band and ultrasonic interferometer.
3. Observation / experimental work.
4. Calculation of dielectric and acoustic parameters.

Third year

1. Result and discussion on the data.
2. Presentation of research paper in conferences.
3. Publication of research work in referral journals.
4. Pre viva-voce presentation.
5. Prewriting of thesis.
6. Final submission of thesis.

8) ***BIBLIOGRAPHY /REFERENCES***

1. “The study of dialectic relaxation in propylgene, glycol-poly, Propylene glycol mixtures.” R. J. Sengwa etal, polymer 43(2002)- 1467-1471 Elsevier Publications.
2. “Dielectric Physics” August Chelkowsky, Elsevier scientific publishing company, Amsterdam, New York(1950).
3. “Dielectric Properties of Molecular Behavior” – Van Nostrand, London (1968), Hill N.E., Vaughan W. E., price A.Herd Devier M.
4. "Dielectric studies of Binary Mixture of n-propyl alcohol and ethylendiamine." BS. Narwad, P.G. Gawali, G.M. Kalamse, Journal of Chemical Science, Indian academy of Sciences, Vol. No. 117, Nov-2005, 673-678.
5. "Effect of particle size and temperature on dielectric of PLZT ceramics at 9.85GHz B.K Bangane and P.G. Gawali et al. International Journal of Physics and Mathematical Sciences ISSN: 2277-2111, 2014.
6. Debye P. Polar molecules, The Chemical Catlog Company, Inc. New York (1929).
7. Peter Hedvig. Dielectric Spectroscopy of Polymer, Adam Higher Lid. Bristal (1977).
8. Krishnaji, Progress Report of Microwave Research Lah, Allahabad University, Allahabad No. 4 (1965).
9. K. Samatha et al. Journal of Pure and Applied Ultrasonics 20(1998) PP1-7.
10. Ravichandran S. Journal of Chemical Sciences, Vol. (8), 12-17, Nov-2011.
11. S.K. Pradhan, Journal of Pure and Applied Physics, Vol. 50., march 2012, pp 161-166.
12. Pratibha S. Agrawal, European Journal of Scientific Research, Vol.45, No.3 (2010), pp 470-475.
13. R. Ezhill Paval and S. Renuka International Journal in Physics chemistry, 2011, 1 (1) 32-37.
14. P.S. Nikam et al. Indian Journal of Pure Applied Physics, Vol. 39 July 2001, PP 433-437.
15. S. Thirumaran et al. APRN, Journal of Engineering and Applied science, Vol. 4 No. 4 June-2009.
16. Ph.D. Thesis of R.S. Kawle, S.R.T.M. University, Nanded, Aug-2013.
17. Sachin Zade, 'Rasayan', Journal of Chemistry, Vol. 4 No. 3 (2011) 620-629.
18. S. Thirumara etal, Archives of Physics Research, 2011 2(2): 149-156.

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